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# 丝兰提取物在家畜有害气体减排及健康养殖方面的应用

孙登生　史彬林*　金　晓　佟满满　闫素梅

（内蒙古农业大学动物科学学院，呼和浩特 010018）

摘　要：丝兰提取物（YSE）的主要活性成分有甾体皂甙、白藜芦醇、麟凤兰多酚等，具有广泛的生物学功能。YSE 早期研究集中于反刍动物瘤胃发酵方面，以降低其生长过程中产生的有害气体。近年来，关于 YSE 作为饲料添加剂改善动物健康与促进生长的报道日趋增多。本文总结了 YSE 对于动物养殖有害气体减排的作用，主要介绍对家畜生产过程中产生的 2 种主要有害气体——甲烷和氨气的减排作用，并分别总结了 YSE 对于不同家畜及试验动物在改善健康及促进生长方面的作用。

关键词：丝兰；瘤胃发酵；健康养殖；生长；家畜

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丝兰（*Yucca*）属龙舌兰科（*Agavaceae* family），原产于美国西南部和墨西哥北部沙漠地区，目前在我国南方地区也有引种栽培。丝兰提取物（*Yucca schidigera* extract,YSE）的主要活性成分为皂甙和多酚类物质[1-2]。丝兰茎部干物质中含有高达 10%的甾体皂甙，是含量最为丰富的皂甙源之一[3]。YSE 早期在动物生产中的应用主要为调节胃肠道功能，表现为降低畜禽有害气体排放，这主要归因于其皂甙成分[1,4]。丝兰的表皮中含有丰富的多酚类物质，如白藜芦醇和麟凤兰多酚[2]。白藜芦醇可以有效清除体内的羟自由基（$\cdot OH^-$）、超氧阴离子自由基（$\cdot O_2^-$），并能抑制细胞中氧自由基（ROS）的形成，保护机体免受由 ROS 引起的在细胞膜和 DNA 中脂质过氧化损伤[5]。而麟凤兰多酚在结构上与白藜芦醇相似，也具有自由基清除功能[1-2]。随着对上述成分分析的深入，近年来研究着重探寻其在健康养殖方面的应用。

## 1　YSE 在反刍动物生产中的应用

### 1.1　有害气体减排作用及其机理

YSE 能够降低反刍动物瘤胃内甲烷[6-7]和氨气[8]的产量。在不同的试验条件下，YSE 对

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作者简介：孙登生(19-)，男，硕士，研究方向为动物环境与营养。E-mail: workingsun@live.cn

*通信作者：史彬林，教授，博士生导师，E-mail: shibinlin@yeah.net

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于瘤胃产气量的影响程度不尽相同[6,9]。当以干物质与可消化干物质水平评估 YSE 对甲烷产量的影响时，所得结果也存在差异[10]。为了避免丝兰在瘤胃发酵和饲料消化过程中的副作用，皂甙水平需控制在 10 g/kg（干物质水平）内[11]。但一些研究显示，YSE 并未有效降低反刍动物的甲烷[12-14]、氨气或一氧化氮产量[13]。

YSE 中存在 2 种能够抑制瘤胃氨气产生的成分，分别为皂甙和多糖，但二者机理不同。皂甙能够通过其抗原虫的能力间接地降低瘤胃中氨气的产生[15]。丝兰皂甙能够与原虫细胞膜上的胆固醇相结合，造成细胞膜破裂、细胞水解，导致瘤胃内原虫数量的降低[3]。需注意的是，皂甙抗原虫能力（即与胆固醇结合的能力）的发挥需以皂甙结构的完整为前提，即皂甙结构中既需包含主链，又需包含侧链[3]。除抗原虫能力外，丝兰皂甙还能够抑制革兰氏阳性菌的数量[16]，并对脱氨作用产生抑制[17]，这些作用均会促进瘤胃内氨气浓度的降低。而多糖部分虽能够直接降低氨气含量，但其对氨气的抑制能力很有限[15]。

YSE 通过多种途径降低瘤胃中甲烷的产生。一般认为 YSE 主要通过抑制瘤胃中产氢菌的产生而抑制甲烷的产生[15]。此外，YSE 对原虫的毒性也会降低甲烷产量[11]。因瘤胃中原虫和产甲烷菌间互为共生关系[12]，当饲粮中加入 YSE 时，瘤胃内的原虫数量会降低，这会导致产甲烷菌数量的下降，最终影响到甲烷的产量[17]。还有一种说法为：YSE 会显著提高瘤胃微生物数量，使瘤胃内环境会向有利于产丙酸菌增殖的方向发展[10]；而丙酸与甲烷呈竞争关系，争夺可用氢[18]，丙酸产量的上升会导致瘤胃甲烷产量的降低[19]。

### 1.2　健康养殖中的应用

饲粮中添加 YSE 能降低奶牛的干物质采食量，升高饲料向牛奶的转化率[20]；提升绵羊的平均日增重（ADG）、饲料转化率（FCR）及营养物质表观消化率[8]。

有研究表明，低剂量的丝兰皂甙能够直接刺激包括纤维素分解菌在内的一些瘤胃内细菌的生长，因而可以不受其驱原虫能力的影响而提高饲料的消化率[21]。高剂量的丝兰皂甙对瘤胃内环境的调节主要表现为驱原虫的作用[21]。丝兰皂甙对一些瘤胃及肠道内细菌的生长也有抑制作用，如牛链球菌（*Streptococcus bovis*）[15]、大肠杆菌 K-12[22]。YSE 中的多酚类物质也具有抗菌作用，如麟凤兰多酚 C 可通过核转录因子κB 降低诱导型一氧化氮合酶蛋白的合成量[23]。YSE 中酚类物质对于花生四烯酸代谢过程中关键酶具有抑制作用，表明其具有抗炎及抗血小板作用[24]。YSE 可通过升高奶牛生殖道中氨气水平而影响其繁殖性能[4]。但

也有报道指出，YSE 能够抑制绵羊窦卵泡的发育[25]。

## 2 YSE 在猪与禽生产中的应用

### 2.1 有害气体减排作用及其机理

YSE 能够显著降低猪和鸡畜舍及其粪便中有害气体的水平，如氨气、三甲胺、二甲胺、异丁酸和硫化氢等，且具有多种利用方式：制成饲料添加剂[26-28]；直接向粪便上喷洒[29]；与微生态制剂一同加入到粪便中[29]或向垫料上喷洒[30]。在上述方式中，将 YSE 制成添加剂与微生态制剂共同添加的效果显著，能够有效地降低猪与禽粪便和畜舍中的有害气体含量[26,29]。此外，不同的作用时间对于 YSE 的使用效果也有一定的影响[29]。因此，选取最佳的作用时间十分关键。

关于 YSE 降低单胃动物产生氨气的原因，目前尚无定论。但脲胺作为粪便中挥发氨气的一部分，本身具有易挥发的性质，因此 YSE 对于粪便中氨气的降低作用可能会受到这一因素影响[28]。此外，YSE 可以改变粪便中的含水量[27]，粪便中含水量与尿酸的降解有着直接的关系[31]，而尿酸会促进氨气的挥发[32]。因此，YSE 可能通过这种间接调控的方式降低单胃动物的氨气产量。此外，丝兰皂甙的抗菌能力对于降低禽类粪便中的有害气体也起到了促进作用[29]。

### 2.2 健康养殖中的应用

饲粮中添加 YSE 能够提升蛋鸡的产蛋数[33]、蛋重[33-34]、饲喂效率（FE）[34-35]、体重及体增重[35]；YSE 也能提升肉仔鸡的 ADG[36-37]、屠宰率[36]，降低 FCR[37-39]，提升蛋白质效率和能量效率[39]，并能降低肉仔鸡的死亡率[40]、粪便干物质和粗灰分含量[26]。YSE 能够提高肉仔鸡的全净膛重和胸肌重[39]，降低胸肌的红度值[40]，还能够降低其相互间的斗殴行为[39]。

YSE 能够提升家禽的抗病能力，提升家禽的新城疫抗体滴度水平[35]，与鸡球虫病疫苗间可能存在协同作用[37]，并能降低蛋鸡血清和蛋黄中胆固醇的浓度[34]。YSE 还具有提升家禽的肠道健康水平的功能，如抑制蛋鸡及肉仔鸡肠道内大肠杆菌的增殖[34,40]，并可促进蛋鸡肠组织的发育[35]。此外，YSE 还能够提升蛋鸡体内的抗氧化酶活力和血清免疫球蛋白 G 浓度[33]，并能提升肉仔鸡的法氏囊相对重量[40]。

YSE 能够作为单一添加剂用于家禽饲养中[36]，也可与其他物质制成复合添加剂，如辛酸[34]、皂树全株粉末[38]、酵母细胞壁[35]、天然沸石[26]等。YSE 在不同时间对于家禽的作用

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也不同[33,41-42]。因此，在生产实践中，不仅应考虑添加剂量，也应考虑添加时间这一因素，以符合精准饲喂（precision feeding）的理念，做到节本增效。

在母猪饲粮中添加 YSE 能够提升其产后对温度调节的能力，并有降低难产发生率和仔猪断奶前死亡率的趋势[43]。此外，YSE 还可通过下调增殖细胞核抗原（proliferating cell nuclear antigen）的基因表达抑制卵巢粒层细胞的增殖，通过调节抗凋亡基因 *bax* 表达量来促进卵巢粒层细胞的细胞凋亡，并且能够刺激孕酮、抑制睾酮的分泌[44]。在饲粮中加入 YSE 能够促进仔猪肠道的发育，从而提升其肠道健康水平[45]。将 YSE 和丁酸钠胶囊共同加入到断奶仔猪饲粮中，其胃和胰腺的相对重量呈升高趋势，小肠的相对重量也得以升高[45]。

## 3 YSE 在其他动物中的应用

### 3.1 小鼠和大鼠

有很多关于 YSE 的研究以小鼠或大鼠为模型，这对于将 YSE 应用于人类及其他动物有着很好的借鉴意义。丝兰的全株提取物、皂甙提取物、非皂甙提取物均能有效降低大鼠血清尿素浓度，并能显著降低尿素循环酶（精氨酸酶和精氨基琥珀酸裂合酶）的活力[46]，这有利于改善肾脏功能；YSE 不仅能够提升正常状态下大鼠的抗氧化水平[47]，还能缓解大鼠中由亚硝酸盐诱导的氧化应激[48]，缓解小鼠中由砷诱导氧化应激所造成的组织病变[49]；YSE 能够调节动物能量代谢、激素水平、血脂和其他生化指标，这对于预防人类营养障碍疾病，如肥胖症，有着很大的潜力[50]。例如，YSE 能够降低由高脂饲粮导致的小鼠血液中葡萄糖、总胆固醇、低密度脂蛋白胆固醇、高密度脂蛋白胆固醇和甘油三酯浓度及天冬氨酸转氨酶、丙氨酸氨基转移酶活力的升高[50]；降低大鼠血液中胆固醇、甘油三酯和低密度脂蛋白的浓度，提高血液中瘦素和胰岛素的浓度，并降低血液中总甲状腺激素及游离组分的浓度[51]。

### 3.2 特种动物及宠物

目前也有一些关于 YSE 对特种动物及宠物的研究，如家兔和宠物犬。YSE 能够提升家兔免疫和抗氧化功能[52]，通过刺激卵巢孕酮分泌而提高家兔的受胎率[53]；还能够降低血液中氨气[52]、总胆固醇及高密度脂蛋白浓度[52]。在饲粮中添加 YSE 能够降低比格犬的肠道产气和粪便中氨气含量，但高剂量（750 mg/kg）YSE 可能会产生副作用[54]，表现为升高血液平均红细胞血红蛋白含量和丙氨酸氨基转移酶活力，且有升高血液胆固醇浓度的趋势[54]。此外，YSE 还能够降低比格犬对饲粮脂肪的消化率[55]。

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## 4 小　结

本文详述了 YSE 作为饲料添加剂在动物生产中的应用研究。YSE 不仅能够降低畜禽生产过程中的有害气体排放和粪便中有害气体的浓度，而且具有提升家畜健康水平和生长性能的潜能。传统上以家畜生长性能作为评价施用饲料添加剂是否有效的主要指标，但这具有很大的局限性。目前，家畜养殖企业对环境造成了巨大的压力，家畜健康状况仍不乐观，畜产品安全问题依然严峻，加上饲料成本的波动，畜牧业的利润空间的降低，这使得家畜养殖企业需认真考虑养殖效益、动物健康、养殖对环境的影响及畜产品品质与安全这些方面，并以此为着手点来解决问题，提升效益，承担起相应的社会责任。YSE 在畜禽中的使用符合目前健康养殖的理念，这使其具有广泛的应用前景。

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# Application of *Yucca schidigera* Extract on Gas Mitigation and Healthy Husbandry in Livestock

SUN Dengsheng SHI Binlin* JIN Xiao TONG Manman YAN Sumei

（*College of Animal Science, Inner Mongolia Agricultural University, Hohhot* 010018, *China*）

Abstract: The main active components in *Yucca schidigera* extract (YSE) are steroidal saponins, resveratrol and yuccals, which possess a wide range of biological functions. Early studies of YSE focused on its impacts on ruminal fermentation, in an attempt to mitigate hazardous gas emission in ruminants. In recent years, there are increasing numbers of reports about applying YSE as a feed additive to promote health and growth performance of animals. The article summarized gas mitigation effects of YSE in animal feeding, with a focus on methane and ammonia reduction. The article also concluded recent studies about the beneficial effects of YSE on different animals including livestock and lab animals in terms of promoting health and growth performance.

Key words: *Yucca schidigera*; ruminal fermentation; healthy husbandry; growth; livestock

*Corresponding author, professor, E-mail: shibinlin@yeah.net （责任编辑 王智航）